Crash & Burn

Fact Sheet

Photo Courtesy Federal Aviation Administration

Sandia predictive fire codes, developed for nuclear safety assessment, can help fight aircraft fires and save lives.

In 1966, the unthinkable happened. A B-52 carrying four nuclear weapons collided with a KC-135 tanker plane at 30,500 feet above the Mediterranean coast of Spain. Three of the weapons fell with the wreckage, landing near Palomares; the fourth landed in the ocean.

In 1968, a B-52 carrying four nuclear weapons crashed and burned about seven miles from the runway at Thule Air Base in Greenland. All the weapons were destroyed by fire.

Accidents happen. Sometimes they're avoidable, but even when they're not, engineering design and analysis can lessen their impact on our physical safety and security.

It's the job of Sandia scientists to determine how weapons will respond to such events and to engineer systems to mitigate undesired outcomes. Responsible for maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile, they must anticipate and plan for the myriad abnormal, uncontrollable events as well as continually refining and reviewing components and systems. Through the Department of Energy's Advanced Strategic Computing Initiative (ASCI), the teraflops high-performance computer was developed in response to a need for higher-resolution, three-dimensional physics modeling to evaluate the aging stockpile without testing. These same capabilities are being used to create simulations of catastrophic events. This magnitude of computing power is necessary to assess — in a reasonable time frame and with extreme confidence — how systems and components respond in every imaginable scenario.

The information gleaned from exploring every aspect of, for example, a plane crash — initial impact, damage to structures, severity and spread of fire based on fuel amounts, wind conditions, effects on objects in and near the fire, effects of fire on materials and thousands of other details — contributes to better design of future systems, the modification of current ones, and comprehensive response strategies. For instance, fire simulations provide the information necessary to determine what sequence of thermal, chemical, and mechanical responses provide signals that could trigger the warhead during the worst-case scenario such as an aircraft crash involving nuclear weapons.

These and other simulations of catastrophic events are being done with computer codes Sandia has developed over many years to investigate the effects of extreme conditions on nuclear weapons and storage containers for hazardous materials. Sandia scientists convert the knowledge gleaned from world-class research in the engineering sciences into computational models of each physical event involved in a particular catastrophe. "Validation" experiments give them confidence in the resulting calculation. Then the computational tools are used to investigate countless crashes, burns, and other accidents — without destroying a single airplane or even lighting a single match.

Sandia computational "crash" codes can help design buildings that are more resistant to terrorist attacks.

The teraflops computer located at Sandia runs computational models of physical reality to create a predictive engineering capability of unprecedented power, versatility, and fidelity.

Can you envision any other uses of these revolutionary engineering computational tools? We can! Sandia has already begun to model other accident and threat scenarios that can impact the safety and security of people in their everyday lives. Car crashes, bullets or missiles piercing objects, and terrorist attacks are just some of the other applications.

Enabled by high-performance computing, the Revolution in Engineering will significantly improve our ability to assess how systems and components respond to every imaginable scenario: What will it take to collapse a bridge, stall an aircraft engine, or activate an airbag prematurely? How will a building respond to a bomb blast? Sandia's advanced simulation capabilities and high-performance computing brings a whole new level of accuracy and understanding to safety design and assessment processes and is essential to providing the levels of safety necessary in our increasingly technical and complex world.

Technology Highlights

- High-fidelity computational models of accident scenarios predict with confidence the response of complex systems subjected to extreme accident environments. Both the computational models and the teraflops computer are unique to Sandia.
- Computational models of accident scenarios are "validated" by Sandia's research in engineering sciences. Confidence in the resulting predictions comes from comparing computational results to data from carefully controlled validation experiments in solid mechanics, fires, fluid dynamics, and thermal sciences.
- Versatility and accuracy of predictive computational tools enables revolutionary advances in the safety and security of the public in all aspects of their daily lives.

Contact

Carl Peterson
(505) 844-6775
e-mail: cwpeter@sandia.gov

Bob Thomas
(505) 844-7450
e-mail: rkthoma@sandia.gov

Sandia National Laboratories